computer implemented

CLAIMS

We claim:

16 A method for determining the optimal tuning parameters in a linear controller, wherein

a) the said linear controller is a device that receives an n-dimensional process variable y(t) from a process and sends an n-dimensional controller output signal u(t) to the said process, where t is the time variable and n is a positive integer,

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b) the said linear controller uses the following type of linear difference equation to calculate the controller output u_k

$$Du_k=Er_k-Cy_k$$

where $y_k=y(t_k)$ is the process variable at time $t_k=t_0+kT_s$, t_0 is the initial time, $T_s>0$ is the constant sampling period, k is a non-negative integer called discrete time variable, $u_k=u(t_k)$ is the controller output at time t_k, and u_k can be subject to lower limit and/or upper limit constraints placed on one or more of its components, $r_k=r(t_k)$ is the set point at time t_k, D, E and C are n by n matrix polynomials in the unit backward shifting operator z^{-1} such that for any discrete time signal x_k, $z^{-1}x_k=x_{k-1}$, and one or more of the said D, E and C contain tuning parameters that are to be determined,

c) the discrete time open-loop transfer function of the said process from the said controller output u_k to the said process variable y_k is $A^{-1}B$, where A and B are known n by n matrix polynomials in the unit backward shifting operator z^{-1}, and

d) the said method finds the optimal values for the said tuning parameters by minimizing the maximum of absolute values of all poles of the discrete time closed-loop transfer function $(A+BD^{-1}C)^{-1}BD^{-1}E$ from the said set point r_k to the said process variable y_k.

17 A method as in Claim 16, wherein the said minimization of the maximum of absolute values of all poles of the closed loop transfer function $(A+BD^{-1}C)^{-1}BD^{-1}E$ from the said set point r_k to the said process variable y_k is subject to constraints placed on the said tuning parameters

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18 A method as in Claim 16, wherein $D=(1-z^{-1})/T_s*I$, where I is the identity matrix of order n, $E=K_1$, $C=K_1$ or $C=K_1+K_2D$ or $C=K_1+K_2D+K_3D^2$ or $C=K_1+K_2D+K_3D^2+K_4D^3$ or $C=K_1+K_2D+K_3D^2+K_4D^3+\ldots+K_mD^{m-1}$, where m is a positive integer, and the coefficients $K_1, K_2, \ldots, K_m$ are n by n constant matrices and are the said tuning parameters.

19 A method as in Claim 17, wherein $D=(1-z^{-1})/T_s*I$, where I is the identity matrix of order n, $E=K_1$, $C=K_1$ or $C=K_1+K_2D$ or $C=K_1+K_2D+K_3D^2$ or $C=K_1+K_2D+K_3D^2+K_4D^3$ or $C=K_1+K_2D+K_3D^2+K_4D^3+\ldots+K_mD^{m-1}$, where m is a positive integer, and the coefficients $K_1, K_2, \ldots, K_m$ are n by n constant matrices and are the said tuning parameters.

20 A linear controller ~~as in Claim 16~~ with its structure and tuning parameter determined by Claim 18 with ~~and m>3.~~

21 A linear controller as ~~in Claim 16~~ with its structure and tuning parameter determined by Claim 19 ~~and m>3.~~